

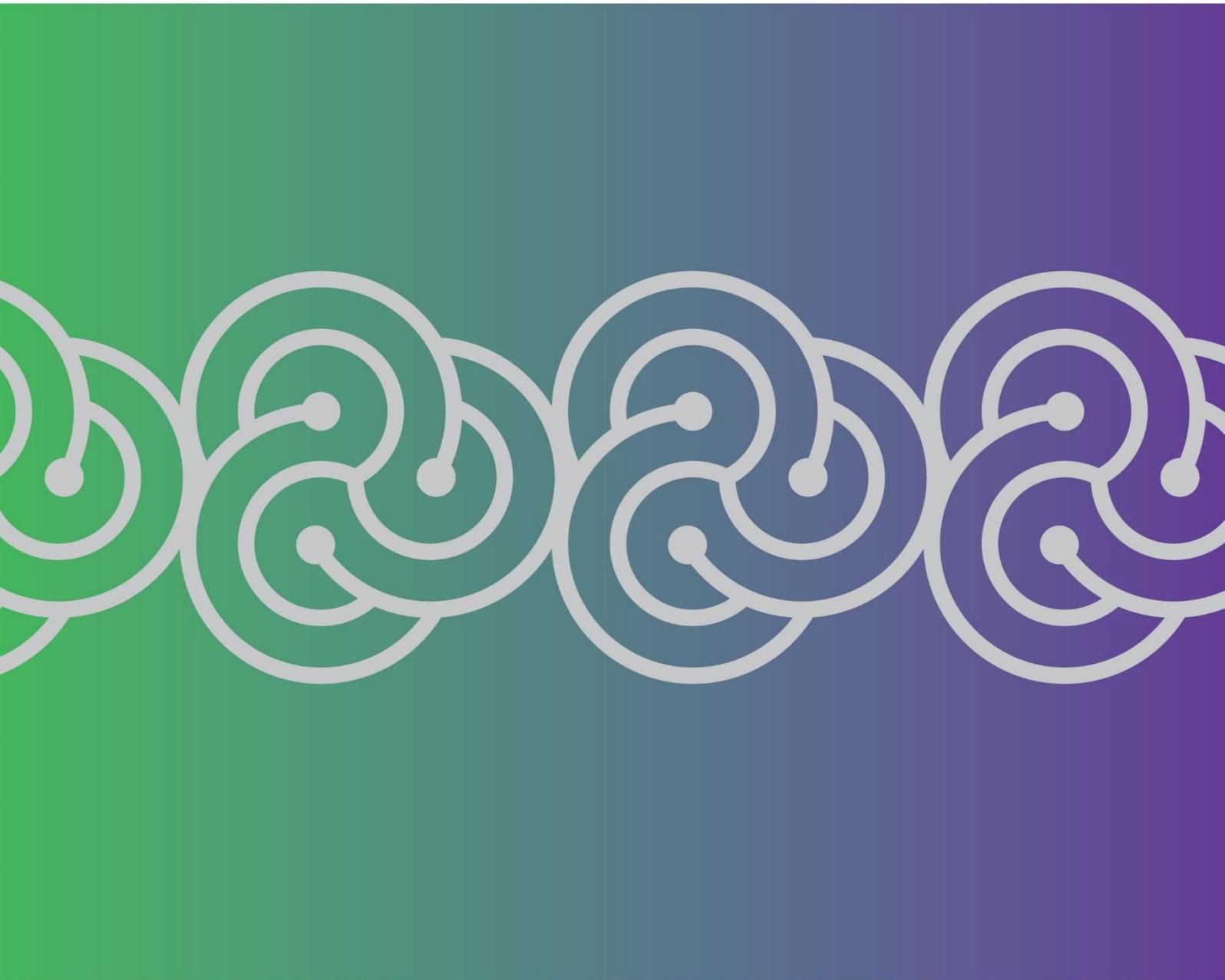


Australian Government
**Australian Radiation Protection
and Nuclear Safety Agency**



Regulatory Guide

How to determine whether a UV source is controlled apparatus



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REGULATORY SERVICES

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1. Introduction

This document is provided to assist controlled persons to determine whether an ultraviolet (UV) source is classed as *controlled apparatus* under the [Australian Radiation Protection and Nuclear Safety Act 1998](#). In particular, it clarifies the conditions specified in section 9 of the [Australian Radiation Protection and Nuclear Safety Regulations 2018](#). A number of case studies where typical UV emitting apparatus have been assessed in accordance with this guide have been published in the document [Regulatory Guide: UV emitting apparatus case studies](#).

This document is valid for both pulsed and continuous sources of UV radiation where the exposure duration is not less than 0.1 μ s. It does not apply to UV lasers.

Reference document

[Radiation Protection Standard for Occupational Exposure to Ultraviolet Radiation \(2006\), ARPANSA Radiation Protection Series No. 12.](#)

Extracts from this document can be found in Appendix 1.

2. Definitions

Exposure limit: the exposure which it is believed that nearly all workers can be repeatedly exposed to without adverse effect (exposure limits for UV are given in Schedule 1 of RPS 12).

Note: The exposure limits apply to artificial sources of UVR. Due to highly variable ambient solar UVR levels the application of exposure limits is not practical and limiting solar UVR exposure to as low as possible is the most effective approach.

Permissible exposure time, t_{PET} : the time it takes to reach the exposure limit (calculated according to Schedule 1 of RPS12).

3. Procedure

This procedure (as show by the flow chart on page 4) will assist you to determine whether your apparatus is controlled or not.

1. If the apparatus is a transilluminator or germicidal lamp where the emission is accessible, it is classed as controlled apparatus.
2. If the apparatus is a fluorescence microscope, a spectrophotometer or a high-performance liquid chromatography (HPLC) where the light source is completely enclosed, it is not controlled apparatus.
3. If there is a reasonably foreseeable abnormal event involving the apparatus that would lead to a person being exposed to levels above the exposure limits, the apparatus is classed as controlled apparatus. Examples of this are: forgetting or using the wrong PPE, possible exposure during normal maintenance, not using prescribed shielding to cover a sample, easy overriding of an interlock etc.
4. If there is a reasonably foreseeable single element failure of the apparatus that would lead to a person being exposed to levels above the exposure limits, the apparatus is classed as controlled apparatus. An example of this is a malfunctioning interlock. A *failsafe* interlock would not lead to a person being exposed as no UV is emitted if the interlock fails.
5. If a person can receive excess levels of radiation when removing protective barriers or access panels that do not require the use of tools or other specialized equipment, then the apparatus is classed as controlled apparatus.
6. Determine if the source emits UV radiation that could lead to a person being exposed to radiation levels in excess of the exposure limits in the course of intended operations or procedures. Calculate the **permissible exposure time**, t_{PET} , according to the method described in Schedule 1 of RPS 12.

Notes:

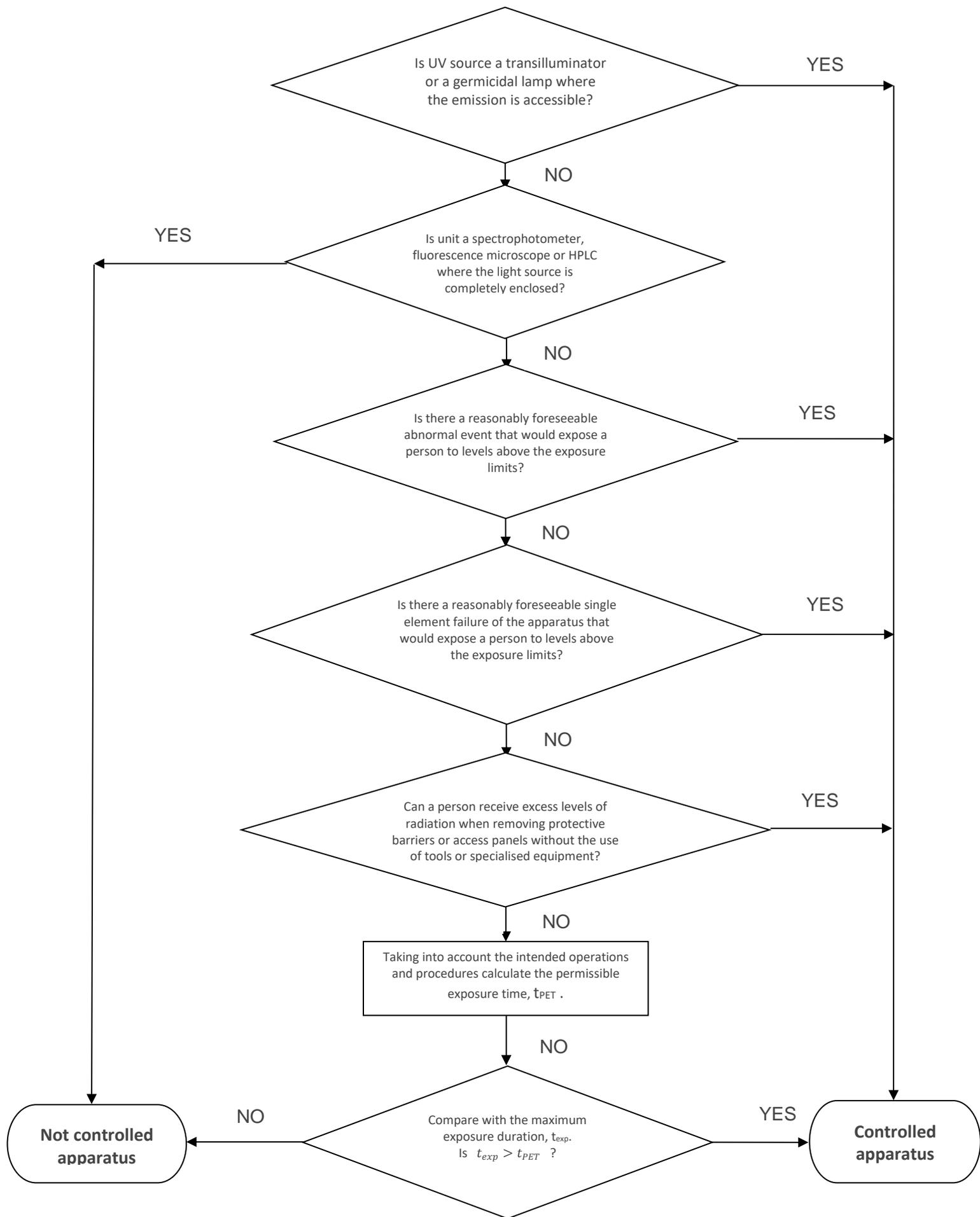
The distance to the source when the unit is in operation should be taken into account. Using the inverse square law the radiation level is calculated at the position where the closest person is situated. If the unit is handheld and no distances are specified: assume that the skin and eyes are 20 cm and 50 cm, respectively, from the source.

Embedded devices can be designed in such a way that it can be considered safe for their intended use and during normal operation as the emission hazard only becomes accessible during service or maintenance. i.e. protective housing, interlocks and other organisational safety measures. The servicing of embedded UV sources can increase the risk of injury as the servicing may include various adjustments. To carry out servicing in a safe manner it may be necessary to implement temporary procedures and safeguards appropriate to the increased level of risk. Manufacturers may provide advice on safe procedures during servicing and maintenance.

Compare with the **maximum exposure duration**, t_{exp} .

If $t_{exp} > t_{PET}$ the apparatus is classed as controlled apparatus.

If $t_{exp} < t_{PET}$ the apparatus is not classed as controlled apparatus.



Appendix 1

Extracts from Schedule 1 Radiation Protection Standard for Occupational Exposure to Ultraviolet Radiation (2006)

Radiation Protection Series No. 12

Exposure limits (EL) for UVR from artificial sources¹

- S1.1 The EL for occupational exposure to UVR incident upon the skin or eye where irradiance values are known and the exposure duration is controlled are as below. Note that S1.2 and S1.3 must both be satisfied independently.
- S1.2 For the UV-A spectral region 315 to 400 nm, the total radiant exposure on the unprotected eye must not exceed 10 kJ.m⁻² within an 8 hour period and the total 8 hour radiant exposure incident on the unprotected skin must not exceed the values given in Table 1. Values for the relative spectral effectiveness are given up to 400 nm to expand the action spectrum into the UV-A for determining the EL for skin exposure.
- S1.3 In addition, the ultraviolet radiant exposure in the actinic UV spectral region (UV-B and UV-C from 180 to 315 nm) incident upon the unprotected skin and unprotected eye(s) within an 8 hour period must not exceed the values given in Table 1.
- S1.4 For broadband sources emitting a range of wavelengths in the ultraviolet region (ie most UVR sources), determination of the effective irradiance of such a broadband source is done by weighting all wavelengths present in the emission with their corresponding spectral effectiveness by using the following weighting formula:

$$E_{\text{eff}} = \sum E_{\lambda} \cdot S_{\lambda} \cdot \Delta_{\lambda}$$

where

- E_{eff} = Effective irradiance in W.m⁻² (J.s⁻¹.m⁻²) normalised to a monochromatic source at 270 nm
- E_{λ} = Spectral irradiance in W.m⁻².nm
- S_{λ} = Relative spectral effectiveness (unitless)
- Δ_{λ} = Bandwidth in nanometres of the calculated or measurement intervals

- S1.5 Permissible exposure time in seconds for exposure to actinic UVR incident upon the unprotected skin or eye may be computed by dividing 30 J.m⁻² by E_{eff} in W.m⁻². The maximum exposure duration may also be determined using Table 2 of this Schedule which provides representative exposure durations corresponding to effective irradiances in W.m⁻² (and $\mu\text{W.cm}^{-2}$).

¹ These exposure limits are intended to be used as guidelines only for solar UVR exposure

Table 1: Ultraviolet radiation exposure limits and relative spectral effectiveness

Wavelength (nm) ^a	Exposure limit (J.m-2)	Exposure limit (mJ.cm-2)	Relative spectral Effectiveness (S _λ)
180	2 500	250	0.012
190	1 600	160	0.019
200	1 000	100	0.030
205	590	59	0.051
210	400	40	0.075
215	320	32	0.095
220	250	25	0.120
225	200	20	0.150
230	160	16	0.190
235	130	13	0.240
240	100	10	0.300
245	83	8.3	0.360
250	70	7.0	0.430
254 ^b	60	6.0	0.500
255	58	5.8	0.520
260	46	4.6	0.650
265	37	3.7	0.810
270	30	3.0	1.000
275	31	3.1	0.960
280 ^b	34	3.4	0.880
285	39	3.9	0.770
290	47	4.7	0.640
295	56	5.6	0.540
297 ^b	65	6.5	0.460
300	100	10	0.300
303 ^b	250	25	0.120
305	500	50	0.060
308	1 200	120	0.026
310	2 000	200	0.015
313 ^b	5 000	500	0.006

Table 1: (continued) Ultraviolet radiation exposure limits and relative spectral effectiveness

Wavelength (nm) ^a	Exposure limit (J.m-2)	Exposure limit (mJ.cm-2)	Relative spectral effectiveness (S _λ)
315	1.0 × 10 ⁴	1.0 × 10 ³	0.003
316	1.3 × 10 ⁴	1.3 × 10 ³	0.0024
317	1.5 × 10 ⁴	1.5 × 10 ³	0.0020
318	1.9 × 10 ⁴	1.9 × 10 ³	0.0016
319	2.5 × 10 ⁴	2.5 × 10 ³	0.0012
320	2.9 × 10 ⁴	2.9 × 10 ³	0.0010
322	4.5 × 10 ⁴	4.5 × 10 ³	0.00067
323	5.6 × 10 ⁴	5.6 × 10 ³	0.00054
325	6.0 × 10 ⁴	6.0 × 10 ³	0.00050
328	6.8 × 10 ⁴	6.8 × 10 ³	0.00044
330	7.3 × 10 ⁴	7.3 × 10 ³	0.00041
333	8.1 × 10 ⁴	8.1 × 10 ³	0.00037
335	8.8 × 10 ⁴	8.8 × 10 ³	0.00034
340	1.1 × 10 ⁵	1.1 × 10 ⁴	0.00028
345	1.3 × 10 ⁵	1.3 × 10 ⁴	0.00024
350	1.5 × 10 ⁵	1.5 × 10 ⁴	0.00020
355	1.9 × 10 ⁵	1.9 × 10 ⁴	0.00016
360	2.3 × 10 ⁵	2.3 × 10 ⁴	0.00013
365 ^b	2.7 × 10 ⁵	2.7 × 10 ⁴	0.00011
370	3.2 × 10 ⁵	3.2 × 10 ⁴	0.000093
375	3.9 × 10 ⁵	3.9 × 10 ⁴	0.000077
380	4.7 × 10 ⁵	4.7 × 10 ⁴	0.000064
385	5.7 × 10 ⁵	5.7 × 10 ⁴	0.000053
390	6.8 × 10 ⁵	6.8 × 10 ⁴	0.000044
395	8.3 × 10 ⁵	8.3 × 10 ⁴	0.000036
400	1.0 × 10 ⁶	1.0 × 10 ⁵	0.000030

^a Wavelengths chosen are representative; other values should be interpolated at intermediate wavelengths

^b Emission lines of a mercury discharge spectrum

Table 2: Limiting ultraviolet exposure durations based on exposure limit

Duration of exposure per day		Effective irradiance	
		$E_{\text{eff}} (\text{W}\cdot\text{m}^{-2})$	$E_{\text{eff}} (\mu\text{W}\cdot\text{cm}^{-2})$
8	Hr	0.001	0.1
4	Hr	0.002	0.2
2	Hr	0.004	0.4
1	Hr	0.008	0.8
30	Min	0.017	1.7
15	Min	0.033	3.3
10	Min	0.05	5
5	Min	0.1	10
1	Min	0.5	50
30	Sec	1.0	100
10	Sec	3.0	300
1	Sec	30	3 000
0.5	Sec	60	6 000
0.1	Sec	300	30 000